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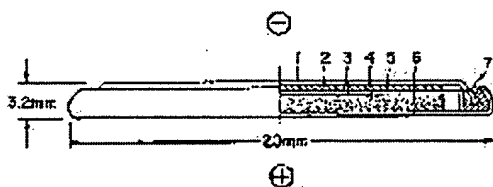
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(54) NONAQUEOUS SECONDARY BATTERY

(57)Abstract:

PURPOSE: To provide high discharge potential, high energy density, long charge and discharge cycle life and high safety by charging a negative electrode active material with lithium ions for changing the basic structure of the crystal thereof, and keeping the basic structure unchanged at charge and discharge processes.

CONSTITUTION: This nonaqueous secondary battery comprises a nonaqueous electrolyte containing a positive electrode active material, a negative electrode active material and lithium salt. The negative electrode active material is obtained by charging (preferably electrochemically) lithium ions into a transition metal oxide allowed to contain lithium. In this case, the lithium ions are charged until both the occurrence of a change in the basic structure of the transition metal crystal (change in the basic structure of the transition metal oxide to be



confirmed via a change in an X-ray diffraction pattern), and the non-occurrence of a substantial change in the changed crystalline basic structure of the lithium containing transition metal oxide charged with the lithium ions at charge and discharge processes (that is, until occurrence of such state as free from substantial change in X-ray diffraction pattern). The transition metal oxide is, for example, ipMO_j , where M is Ti, V or the like, (p) is a value between 0 and 3.1, and (j) is a value between 1.6 and 4.1.

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CLAIMS

[Claim(s)]

[Claim 1] The nonaqueous rechargeable battery which is the transition-metals oxide to which the basic structure of a crystal was changed in the nonaqueous rechargeable battery which consists of nonaqueous electrolyte containing positive active material, a negative-electrode active material, and lithium salt when this negative-electrode active material inserted a lithium ion, and is characterized by the basic structure of the crystal after the change being in the condition of not changing with charges and discharges.

[Claim 2] The nonaqueous rechargeable battery according to claim 1 with which the transition-metals oxide before this lithium ion insertion consists of a transition-metals oxide expressed with Li_pMO_j (however, M expresses at least a kind of transition metals chosen from Ti, V, Mn, Co, Fe, nickel, Cr, Nb, and Mo, and p is in the range of 0-3.1, and j is in the range of 1.6-4.1).

[Claim 3] The nonaqueous rechargeable battery according to claim 1 with which this negative-electrode active material consists of a lithium content transition-metals oxide expressed with Li_xMO_j (however, M expresses at least a kind of transition metals chosen from Ti, V, Mn, Co, Fe, nickel, Nb, and Mo, and x is in the range of 0.17-11.25, and j is in the range of 1.6-4.1).

[Claim 4] the reinforcement of the X diffraction maximum peak in within the limits of five - 70 angle of diffractions (2theta) of the X diffraction pattern according [change of the basic structure of the crystal by lithium ion insertion] to the CuK alpha rays of the transition-metals oxide before lithium ion insertion changes to 1/5 or less -- the nonaqueous rechargeable battery according to claim 1 which is change checked.

[Claim 5] The nonaqueous rechargeable battery according to claim 1 characterized by all the reinforcement of the X diffraction peak in within the limits of five - 70 angle of diffractions (2theta) of the X diffraction pattern according [the basic structure of this negative-electrode active material] to CuK alpha rays by being in the range of 20-1000cps.

[Claim 6] The nonaqueous rechargeable battery according to claim 1 this whose negative-electrode active material is the oxide of the transition metals with which the lithium ion was inserted electrochemically.

[Claim 7] The nonaqueous rechargeable battery according to claim 1 whose transition-metals oxide before this lithium ion insertion is a transition-metals oxide manufactured by baking.

[Claim 8] The nonaqueous rechargeable battery according to claim 1 obtained when this negative-electrode active material inserts a lithium ion in the lithium content transition-metals oxide manufactured by baking further.

[Claim 9] The nonaqueous rechargeable battery according to claim 1 with which this negative-electrode active material consists of a lithium content transition-metals oxide expressed with $\text{Li}_x\text{M}_q\text{V}_{1-q}\text{O}_j$ (however, M expresses transition metals, p is in the range of 0-3.1, x is in the range of 0.17-11.25, and q is in the range of 0-0.7, and j is in the range of 1.3-4.1).

[Claim 10] The nonaqueous rechargeable battery according to claim 1 with which this

positive active material consists of a lithium content transition-metals oxide expressed with Li_yMO_z (however, M expresses a kind of transition metals at least, and expresses at least a kind of transition metals of the transition metals a kind is chosen [transition metals] from Co, Mn, nickel, V, and Fe, and y is in the range of 0.2-1.2, and z is in the range of 1.4-3).

[Claim 11] This positive active material Li_yCoO_2 , Li_yNiO_2 , and $\text{Li}_y\text{Co}_a\text{Ni}_{1-a}\text{O}_2$, $\text{Li}_y\text{Co}_b\text{V}_{1-b}\text{O}_2$ and $\text{Li}_y\text{Co}_b\text{Fe}_{1-b}\text{O}_2$, $\text{Li}_y\text{Mn}_2\text{O}_4$, $\text{Li}_y\text{Mn}_c\text{Co}_{2-c}\text{O}_4$, and $\text{Li}_y\text{Mn}_c\text{Ni}_{2-c}\text{O}_4$, $\text{Li}_y\text{Mn}_c\text{V}_{2-c}\text{O}_4$ And $\text{Li}_y\text{Mn}_c\text{Fe}_{2-c}\text{O}_4$ (However, y is in the range of 0.5-1.2, and a is in the range of 0.1-0.9.) b -- the range of 0.8-0.98 -- it is -- c -- the range of 1.6-1.96 -- it is -- and z -- the range of 2.01-2.3 -- it is -- the nonaqueous rechargeable battery according to claim 1 which consists of a lithium content transition-metals oxide expressed.

[Claim 12] The nonaqueous rechargeable battery with which this negative-electrode active material is a lithium content transition-metals oxide, and the crystal is characterized by having the basic structure characterized when all the reinforcement of the X diffraction peak in within the limits of five - 70 angle of diffractions of the X diffraction pattern by CuK alpha rays is in the range of 20-1000cps in the nonaqueous rechargeable battery which consists of nonaqueous electrolyte containing positive active material, a negative-electrode active material, and lithium salt.

[Claim 13] The nonaqueous rechargeable battery according to claim 12 with which this negative-electrode active material consists of a lithium content transition-metals oxide expressed with Li_xMO_j (however, M expresses at least a kind of transition metals chosen from Ti, V, Mn, Co, Fe, nickel, Nb, and Mo, and x is in the range of 0.17-11.25, and j is in the range of 1.6-4.1).

[Claim 14] The nonaqueous rechargeable battery according to claim 12 with which this negative-electrode active material consists of a lithium content transition-metals oxide expressed with $\text{Li}_x\text{MqV}_{1-q}\text{O}_j$ (however, M expresses transition metals, x is in the range of 0.17-11.25, and q is in the range of 0-0.7, and j is in the range of 1.3-4.1).

[Claim 15] The nonaqueous rechargeable battery characterized by this negative-electrode active material consisting of a lithium content transition-metals oxide expressed with $\text{Li}_x\text{MqV}_{1-q}\text{O}_j$ (however, M expresses transition metals, x is in the range of 0.17-11.25, and q is in the range of 0-0.7, and j is in the range of 1.3-4.1) in the nonaqueous rechargeable battery which consists of nonaqueous electrolyte containing positive active material, a negative-electrode active material, and lithium salt.
